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THE McCOWAN ROAD RIGHT-OF-WAY STUDY: STUMP SPROUTING AND SUCKERING, AND THE DEVELOPMENT OF WOODY VEGETATION IN THE FOURTH SEASON FOLLOWING CLEARCUTTING

Report No 89-30-K

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ABSTRACT

A study was initiated in 1984 to describe the growth of tree species following clearing of a wooded area for a transmission right-of-way. This report discusses the changes in woody species composition during the first 4 years of the study, concentrating on the relative importance of root suckers, stump sprouts and tree seedlings to the formation of the tree canopy. The survival and growth rates of sprouts and suckers associated with selected stumps of the major incompatible species are also reported.

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EXECUTIVE SUMMARY

THE McCOWAN ROAD RIGHT-OF-WAY STUDY: STUMP SPROUTING AND SUCKERING, AND THE DEVELOPMENT OF WOODY VEGETATION IN THE FOURTH SEASON FOLLOWING CLEARCUTTING

The vegetational management techniques used on Ontario Hydro rights-of-way must be capable of controlling tall-growing (incompatible) species. The development of an integrated control policy is complicated by the fact that this vegetation develops from sources with contrasting growth characteristics. Stems sprouting from the stump or suckering from the root system of ineffectively removed trees have higher growth rates and survivorship potentials than stems developing from seeds. Seedlings however, may be more numerous. It is important to determine the role of these sources in generating problematic stems on the right-of-way.

A survey of the woody vegetation at the McCowan Road right-of-way site was undertaken in the first, second and fourth year post-clearing to document the change in woody species composition and investigate the source of the incompatible stems. The canopy is currently dominated by root suckers of *Populus tremuloides* (trembling aspen), while the groundcover consists of a high density of small shrubs (*Prunus virginiana* (choke cherry) and *Rubus idaeus* (raspberry)). Rapid proliferation of *P. tremuloides* suckers following clearing resulted in a canopy that was 60% vegetative origin by the 1986 survey. Approximately 20 to 25% of the of the *Acer saccharum* (sugar maple) and *Fraxinus americana* (white ash) stems on the site at that time were also of vegetative origin. However, by 1988, an increase in the density of *F. americana* and *A. saccharum* seedlings and a decline in *P. tremuloides* sprouts reversed the total stem composition to one in which 65% originated from seed.

A second study was undertaken to investigate the growth and survival characteristics of sprouts and suckers originating from the stumps of 324 trees which were removed from the site in 1984. The total number of stems associated with the stumps has declined to 1909 stems, a reduction of 30% in 1988. The mean number of stems on each surviving stump is converging to a range of 8 to 10 stems stump^{-1} for all species. Thus the most prolific sprouters, *P. serotina* and *F. americana*, exhibited the highest stem mortality, while the poorer sprouters experienced better survival during the initial 4 years of the study.

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To: Dr. D. Mills
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THE McCOWAN ROAD RIGHT-OF-WAY STUDY: STUMP SPROUTING AND SUCKERING, AND THE DEVELOPMENT OF WOODY VEGETATION IN THE FOURTH SEASON FOLLOWING CLEARCUTTING

1.0 INTRODUCTION

The first stage in the construction of a utility right-of-way in a forested region involves the removal of all tall growing woody vegetation which may interfere with the electrical conductors and structures. In response to this clearing there is usually a tendency towards re-establishment of the previous forest communities (Thibodeau and Nickerson 1986). Species associated with the low-light conditions of the mature forest establish simultaneously with the pioneer tree and shrub species which require the increased light levels (Jensen 1943, Albert and Barnes 1987).

Stems of the tree species come from four distinct sources. Sprouts can quickly develop from the stumps of the removed trees. Suckers can invade from the root system of trees in the neighbouring areas and from the stumps on the right-of-way. The advance regeneration already present prior to clearing is released by the removal of the canopy. Stems will also develop from seed sources in the area. This large diversity in the source of the incompatible stems makes it difficult to develop an integrated management policy to control each source.

Periodic disturbance of the area is necessary to maintain the right-of-way with low growing vegetation compatible to its use by the utility. Vegetative reproduction from sprouts and suckers produces a rapid, dense growth which causes immediate problems. Information is required on the growth rates and survivorship of these stems to schedule the maintenance treatments such that the most effective results are achieved.

Stems originating from seed sources tend to be more numerous and widespread, but have lower initial growth rates. There is the potential for a highly competitive ground vegetation to interfere with the establishment and growth of these seedlings, thus reducing this ever present source. Some shrub communities have been shown to resist tree invasion for several decades (Pound and Egler 1953, Bramble and Byrnes 1976, Niering *et al.* 1986), while various grasses and forbs may also provide a high degree of interference (Suffling 1979, Brown 1989). Direct planting of resistant communities on the right-of-way is possible, however studies on the importance of seedling growth relative to that of the sprouts and suckers is necessary to indicate if this approach is desirable.

A long term study was initiated in a woodlot near McCowan Road in Markham to assess the natural pattern of vegetative development on a newly cleared area. This report is concerned with the development of the woody vegetation at the site during the fourth growing season following clearing. It discusses stump mortality, survivorship and the changes in the growth of sprouts and suckers during the four years. In addition, an investigation into the relative importance of seedlings, sprouts and suckers in the development of an incompatible tree canopy is also included.

2.0 METHOD

The McCowan Road site consists of a 0.3 hectare (70 x 42 m) section of woodlot in Markham, adjacent to an established right-of-way (north of towers 58 and 59 of the 500 kV Cherrywood to Clairville transmission line).

To enable a long-term investigation of the sprouting dynamics, 348 trees (with diameters greater than 7.0 cm at a height of 0.3 m) were marked with aluminum tags. The diameter, height and age of each tree was recorded prior to cutting (Kirby 1984).

This site was selectively cleared of all incompatible woody species in the fall of 1984. The species removed from the site included 107 *Acer saccharum* (sugar maple), 97 *Populus tremuloides* (trembling aspen), 94 *Fraxinus americana* (white ash), 19 *Prunus serotina* (black cherry) and 7 *Tilia americana* (basswood).

Vegetative reproduction in the aspen is primarily by root suckers, while sprouting from the stump is the major source in the other species. (See Arron (1983) for a summary of the factors which affect sprouting and suckering.) The growth of sprouts and suckers from the tagged stumps for the fall of 1985, 1986 and 1987 has been previously reported in Arron (1986) and Brown (1987a, b). The growth in the fourth year of the study was determined in September, 1988. Each stump was located and the number of stems (sprouts and suckers) and the height of the dominant (tallest) stem associated with each stump were recorded. Two hundred and thirty-two stumps were included in the 1985 survey, while all 324 stumps were examined in the subsequent studies.

An investigation was also undertaken to determine the extent of woody growth at the site. The area was sampled in September, 1988 with a grid of 76 1 x 1 m quadrats located at 5 m intervals. Within each quadrat, the number of stems and the height of the tallest stem of each woody species was measured. All stems of the incompatible tree species were further separated into seed or vegetative (sprout and sucker) classes. Previous investigations on the shrub and tree development at this site were in the spring of 1985 (Arron 1985) and September, 1986 (Brown 1987c).

3.0 RESULTS

3.1 The changes in woody vegetation composition

The removal of the tree canopy in 1984 resulted in the immediate invasion of woody species at McCowan Road. Stem densities rose from 4.52 stems m^{-2} in the spring of 1985 to 30.45 stems m^{-2} in the fall of 1986 (Table 1). This proliferation did not continue, and a slight decline in density was observed by 1988. The changes between 1985 and 1986 were primarily attributed to increases in *A. saccharum*, *F. americana*, *P. tremuloides*, *Prunus virginiana* (choke cherry) and *Rubus idaeus* (raspberry) (Figure 1). The increases continued into 1988 for *A. saccharum*, *F. americana and P. virginiana*, while the density of *P. tremuloides* has decreased in 1988. The density of *P. serotina*, which rapidly invaded the site following clearing (density of 2.40 stems

Table 1

The density of woody species at McCowan Road

Species	Common name	Density (stems m^{-2})		
		1985	1986	1988
Acer negundo	Manitoba maple		0.01	
Acer saccharum	sugar maple	0.31	3.69	4.99
Acer spicatum	mountain maple		0.09	
Betula papyrifera	paper birch		0.04	
Carya cordiformis	bitternut hickory		0.01	
Cornus sp.	dogwood	0.02	1.69	0.82
Crataegus sp.	hawthorn	0.04	0.03	0.28
Fagus grandifolia	American beech		0.85	
Fraxinus americana	white ash	1.16	2.92	5.11
Juglans cinerea	butternut		0.01	0.07
Lonicera sp.	honeysuckle		0.01	
Malus sp.	apple		0.07	
Ostrya virginiana	ironwood	0.01	0.01	
Populus tremuloides	trembling aspen	0.56	5.16	2.41
Prunus virginiana	choke cherry		8.07	9.12
Prunus pensylvanica	pin cherry		0.24	0.04
Prunus serotina	black cherry	2.40	1.01	0.04
Rhamnus cathartica	common buckthorn		0.10	0.04
Ribes cynosbati	prickly gooseberry			0.07
Ribes hirtellum	wild gooseberry		0.08	0.16
Rubus allegheniensis	blackberry		0.28	
Rubus idaeus	raspberry	0.03	5.10	4.55
Rubus occidentalis	black raspberry		1.07	
Thuja occidentalis	white cedar			0.01
Tilia americana	basswood	0.01	1.06	0.04
Tsuga canadensis	hemlock			0.01
Ulmus americana	white elm			0.08
Viburnum trilobum	high bush cranberry		0.08	0.12
Viburnum lentago	nannyberry		0.13	0.36
all stems		4.53	30.45	28.85

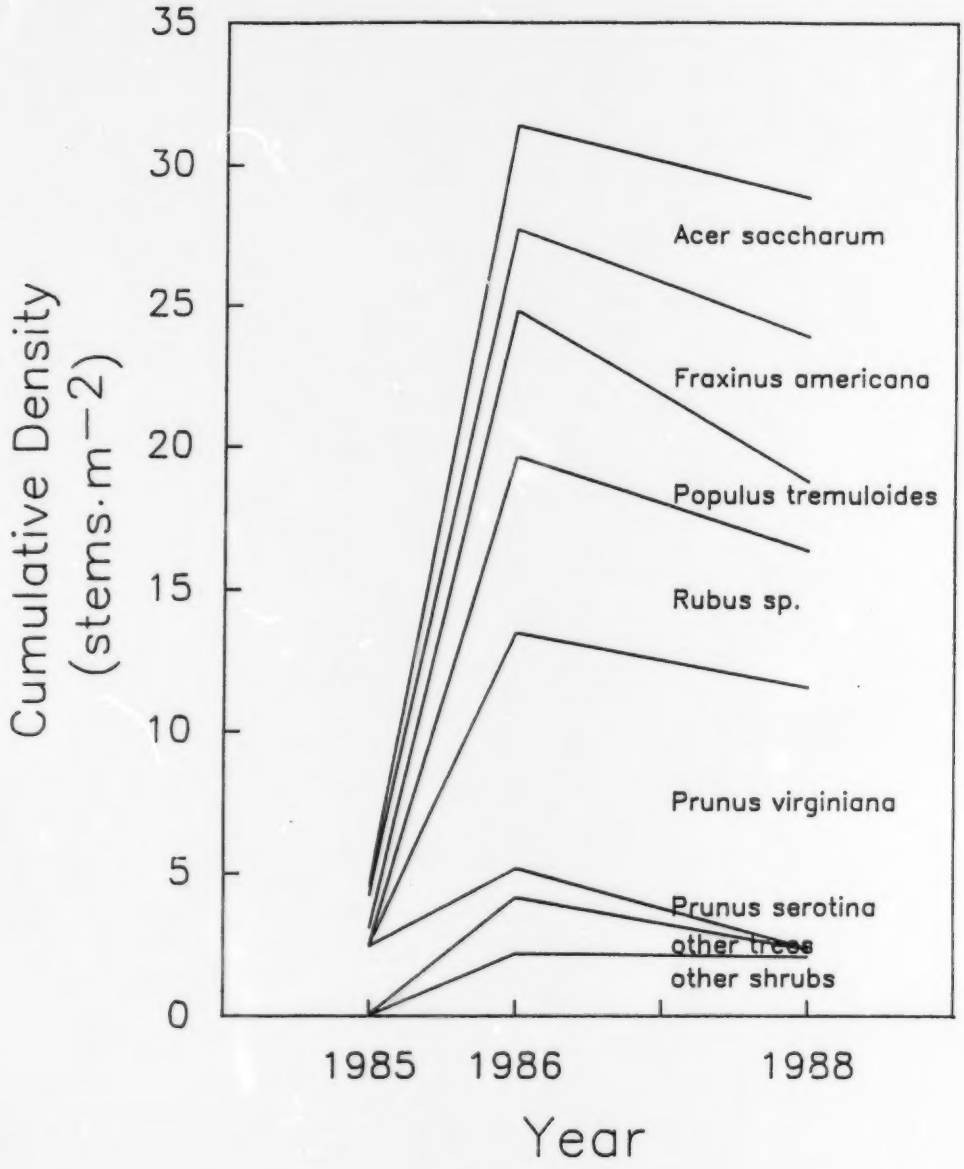

FIGURE 1

CHANGES IN THE DENSITY OF WOODY STEMS FOLLOWING CLEARING OF THE McCOWAN ROAD SITE

m^{-2}, constituting 53% of the stems in 1985) has declined to an insignificant 0.04 stems m^{-2} by 1988. *Fagus grandifolia* (beech) also declined between 1986 and 1988.

The relative contributions of seedlings or saplings and sprouts or suckers to the tree density is shown in Figure 2. The postclearing conditions (spring 1985) primarily consisted of *P. serotina* and *F. americana* seedlings and some advance regeneration of the *P. tremuloides* suckers (Figure 2, and Arron 1985). Rapid proliferation of *P. tremuloides* suckers resulted in a canopy where 60% of the stems were of vegetative origin by the 1986 survey. Approximately 20 to 25% of the *A. saccharum* and *F. americana* stems on the site at that time were also of vegetative origin. By 1988, an increase in the density of *F. americana* and *A. saccharum* seedlings and a decline in *P. tremuloides* sprouts reversed the total stem composition to one in which 65% originated from seeds. However, the sprouts and suckers dominated the canopy layer due to their superior growth rates (Figure 3).

3.2 Stem development on permanently located stumps

Few changes in the number of stumps that produced sprouts or suckers could be observed in 1988 (Figure 4). It appears that significant stump mortality was restricted to the first and second years following cutting, and was important only for *A. saccharum, T. americana* and *F. americana.*

Although stump mortality was minimal, the total number of sprouts and suckers associated with the stumps has declined to 1909 stems, a reduction of 820 stems in 1988. The largest reduction occurred with the number of *F. americana* sprouts (Figure 5). The decline in *P. serotina* that was initially observed in 1987 has continued, while few changes in the number of *A. saccharum, T. americana*, and *P. tremuloides* stems occurred over the last year. The mean number of stems on each surviving stump is converging to a range of 8 to 10 stems $stump^{-1}$ for all species (Figure 6). Thus the most prolific sprouters, *P. serotina* and *F. americana*, exhibited the highest stem mortality, while the poorer sprouters experienced better survival during the 4 years of the study.

Considerable changes have occurred in the growth of the dominant stems (Figure 7). A decrease in the growth rate of *P. serotina, P. tremuloides* and *T. americana* was observed in 1988. This may reflect the slowing down of the enhanced growth associated with the sprouting response, or could be related to the unusually hot and dry conditions in the growing season of 1988. In contrast, the growth rate of *A. saccharum* has continually increased since the year of cutting, changing its ranking from the shortest to the second tallest sprouter.

4.0 DISCUSSION

It is quite apparent that the vegetation composition at the site is continually changing although the rate of this change has declined. The postclearing woody vegetation, dominated by *P. serotina* and *F. americana* has been rapidly replaced by *P. tremuloides, P. virginiana* and *R. idaeus* (Figure 1). *P. tremuloides* is now declining, while more seedlings of *F. americana* and *A. saccharum* are becoming established (Figure 2). The site is developing towards a woody species composition similar to the preclearing conditions. Other studies have indicated similar rapid transitions toward a forest structure (Thibodeau and Nickerson 1986, Albert and Barnes 1987). A beech-maple clear-cut in New Hampshire was initially invaded by *Rubus* sp., *P. virginiana* and some herbaceous species (Jensen 1943). *P. virginiana* became the dominant species by year 5, with a density of 2.05 stems m^{-2}, compared to a total tree density of 6.31 stems m^{-2}. This shrub was gradually overshaded by the trees, and was effectively removed from the understory by year 25 (Marquis 1967). McCowan Road appears to be developing at a much faster rate than this (Figure 1, Table I) and severe competition amongst the trees in this dense canopy is expected to

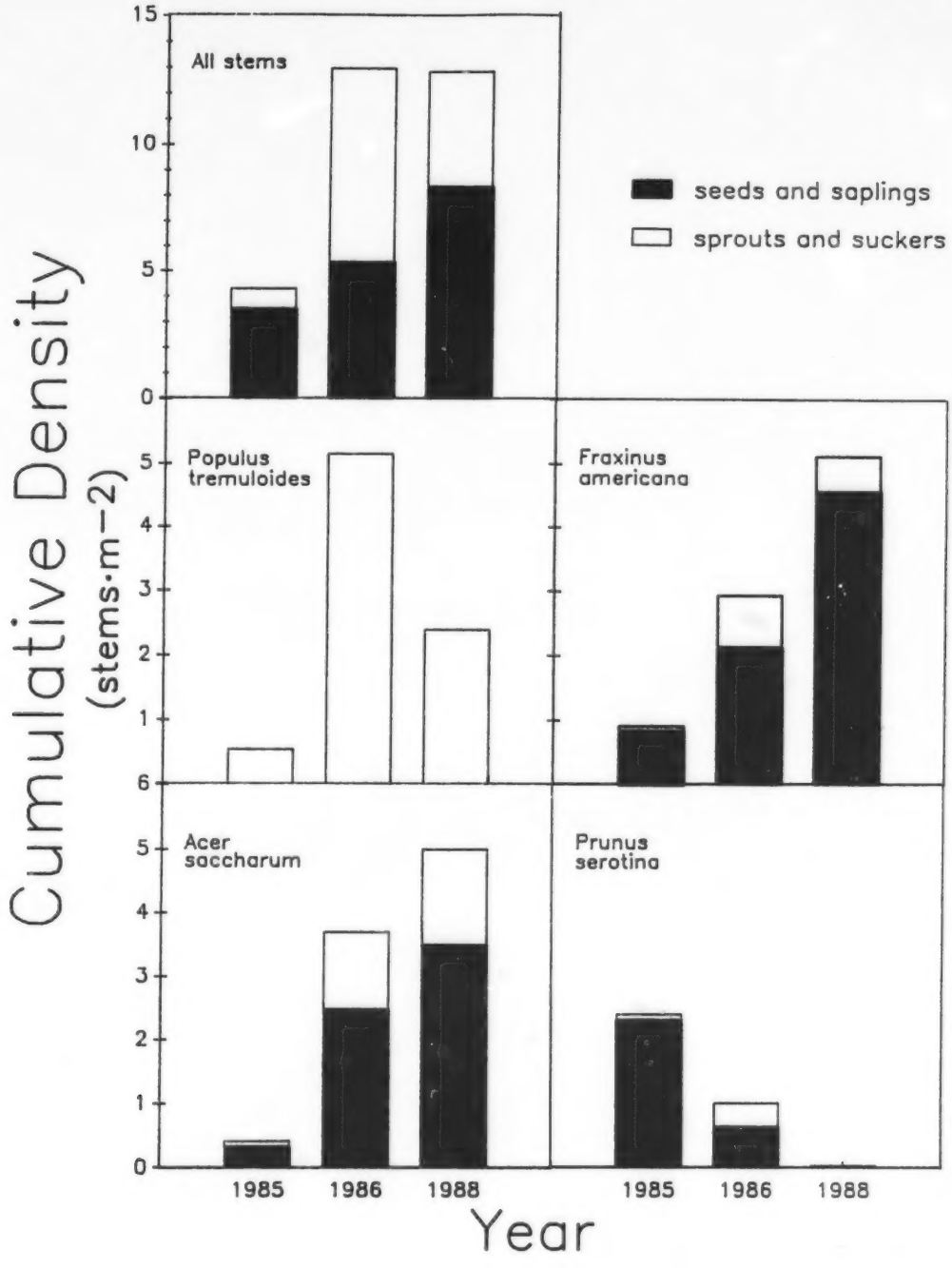

FIGURE 2

THE RELATIVE CONTRIBUTION OF STEMS OF SEEDLING ORIGIN AND THOSE OF SPROUT OR SUCKER ORIGIN TO THE TOTAL STEM DENSITY AT McCOWAN ROAD

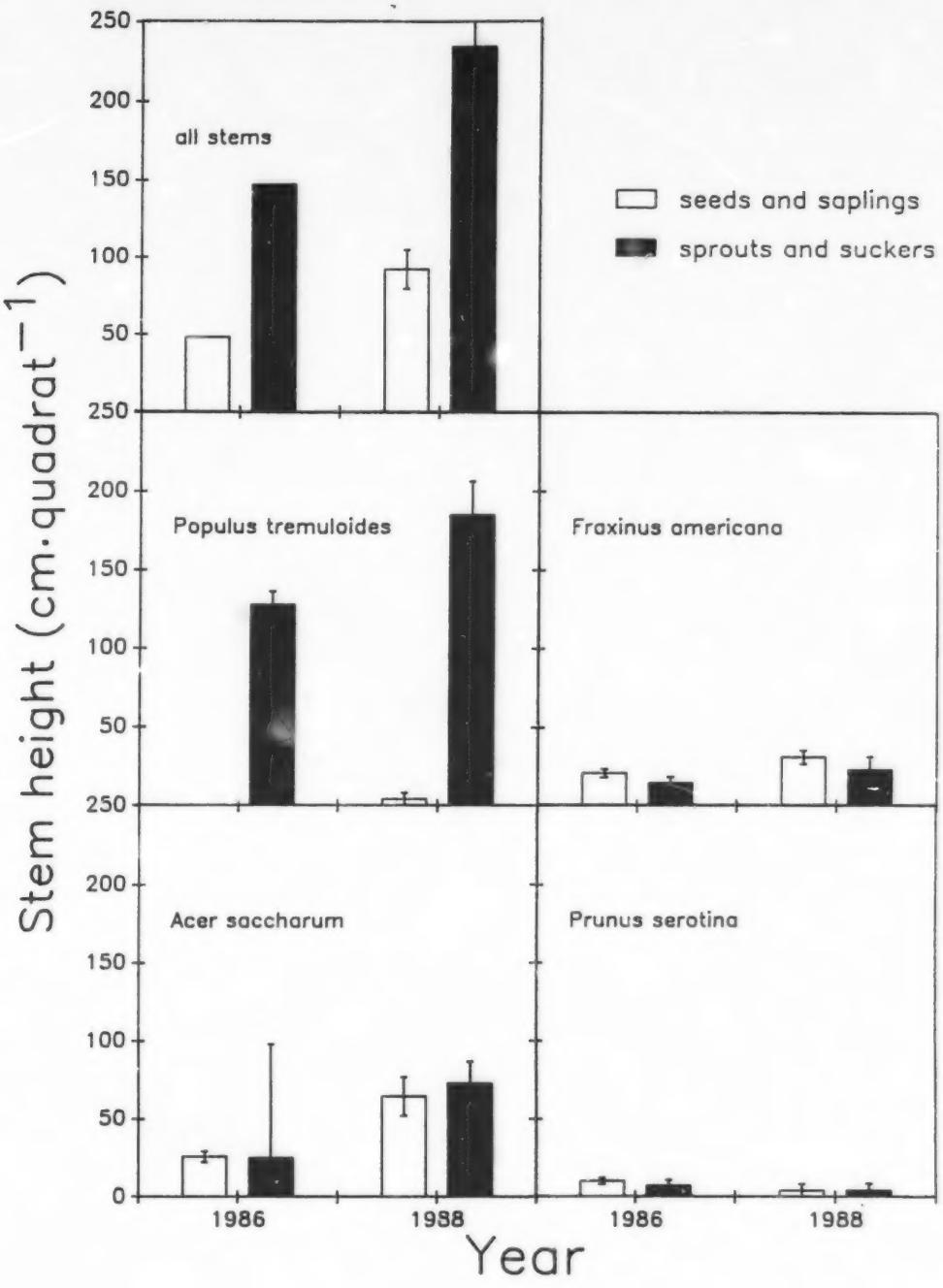

FIGURE 3

THE RELATIVE CONTRIBUTION OF STEMS OF SEEDLING ORIGIN AND THOSE OF SPROUT OR SUCKER ORIGIN TO THE AVERAGE CANOPY HEIGHT AT McCOWAN ROAD

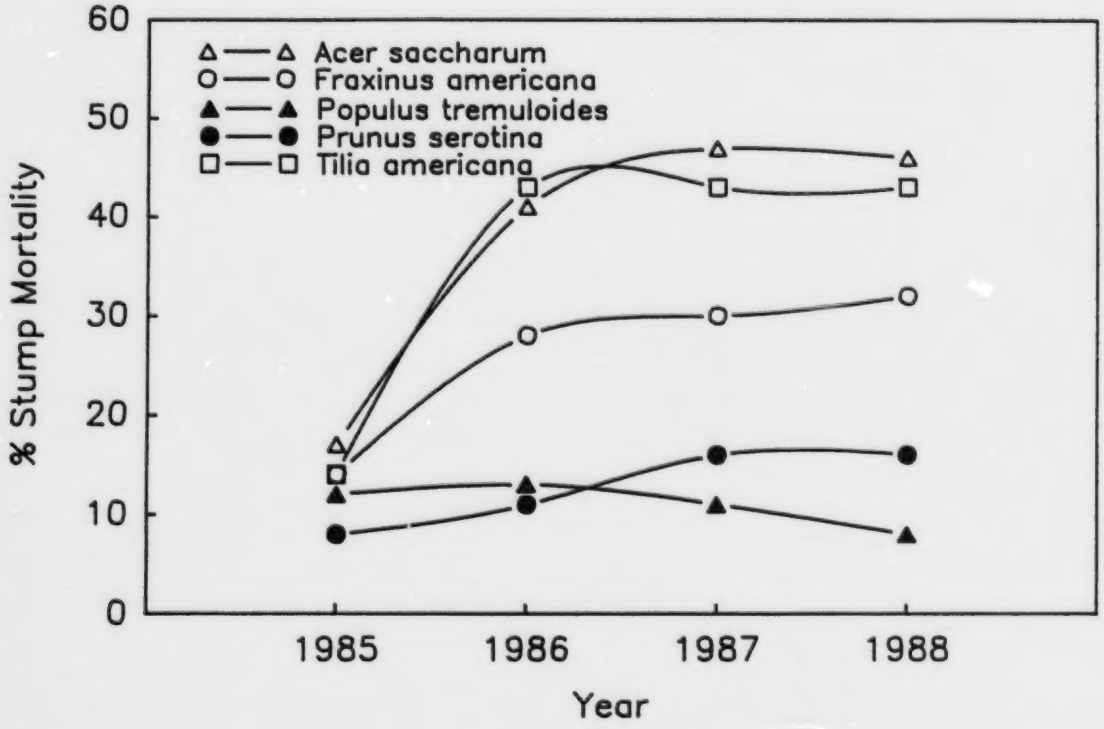

FIGURE 4

MORTALITY OF THE TAGGED STUMPS AT McCOWAN ROAD DURING THE FIRST FOUR YEARS OF THE STUDY

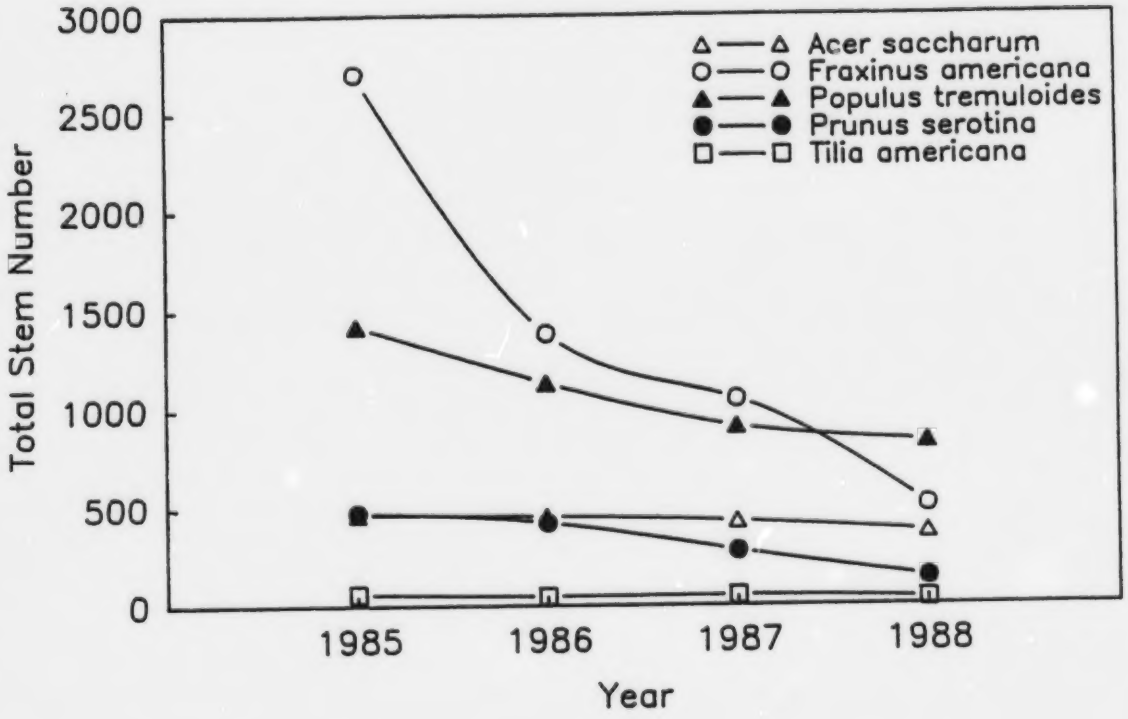

FIGURE 5

CHANGES IN THE TOTAL NUMBER OF SPROUTS OR SUCKERS ASSOCIATED WITH THE TAGGED STUMPS DURING THE FIRST FOUR YEARS OF STUDY AT McCOWAN ROAD

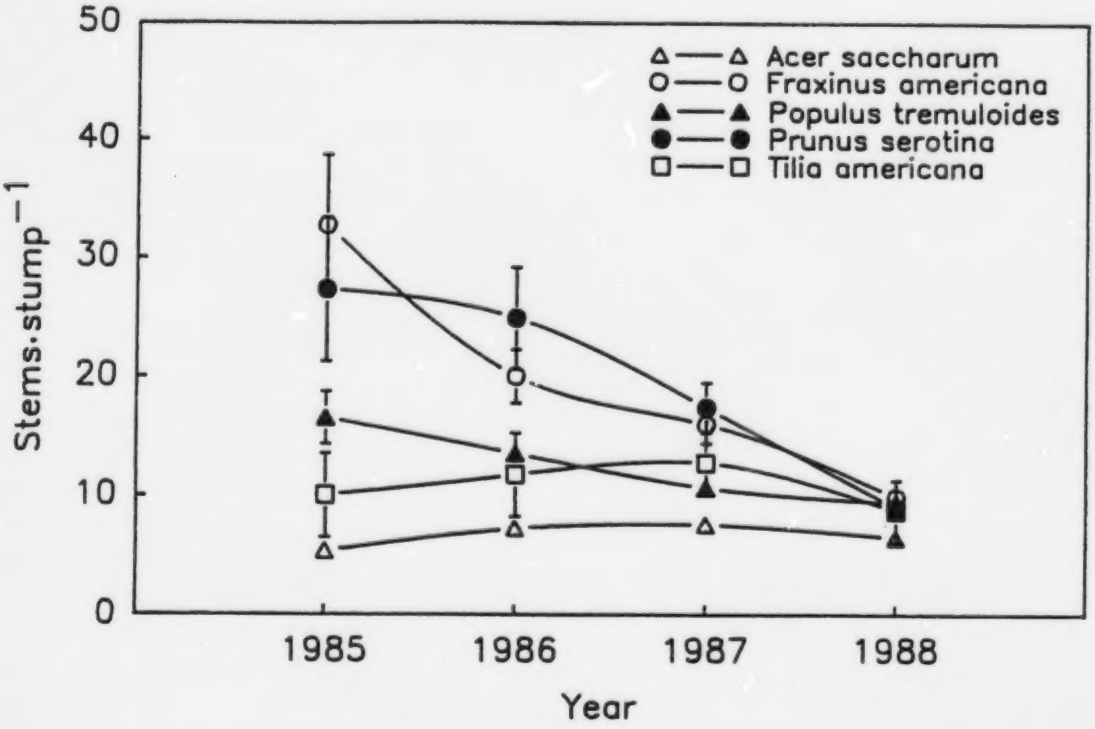

FIGURE 6

THE NUMBER (MEAN $\pm$ SE) OF SPROUTS OR SUCKERS ON THE SURVIVING STUMPS AT McCOWAN ROAD

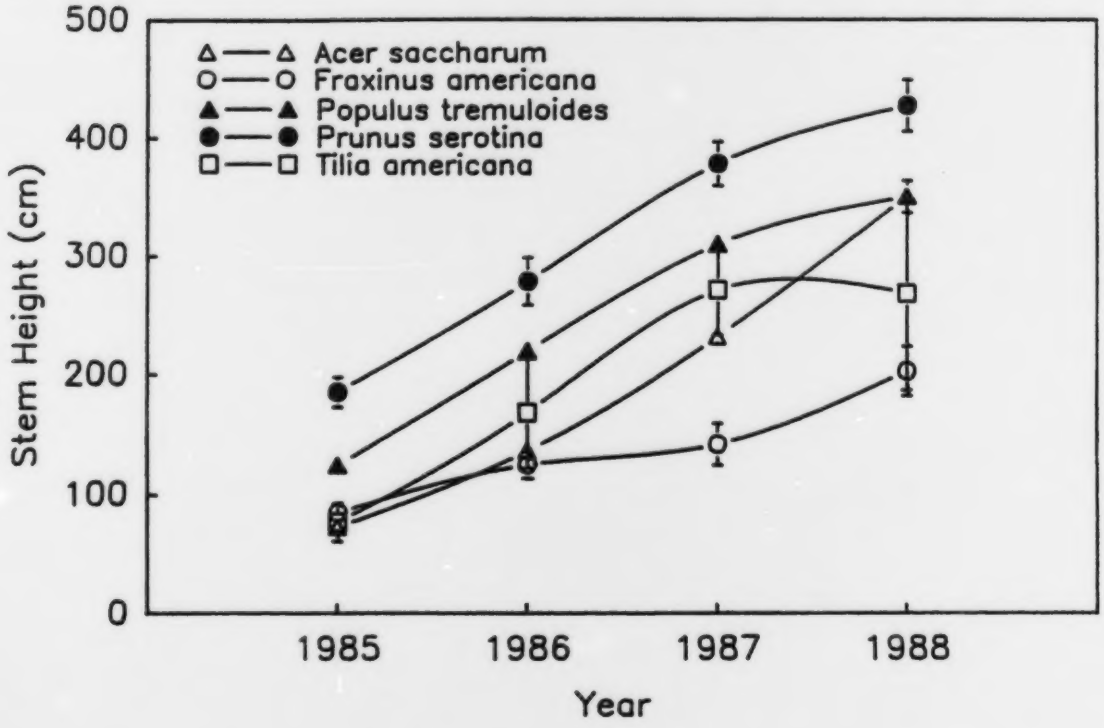

FIGURE 7

THE HEIGHT (MEAN ± SE) OF THE TALLEST SPROUT OR SUCKER ASSOCIATED WITH THE SURVIVING STUMPS AT McCOWAN ROAD

result in a large decrease in stem numbers within the next few years.

It is apparent from this and other studies (Bramble and Byrnes 1976, Allsbrooks *et al.* 1984, Thibodeau and Nickerson 1986) that the ground cover remaining after the clearing of a newly established right-of-way will not inhibit tree establishment. Normally, two to three selective herbicide treatments are required to establish a desirable ground cover on a right-of-way (Niering and Goodwin 1974, Bramble and Byrnes 1976). More extensive site preparation, involving grubbing of the stumps and soil scarification, followed by planting of an appropriate cover crop, may be necessary to rapidly establish a high degree of biological control if chemicals are not available for use (Allsbrooks *et al.* 1984).

Sprouts and suckers have occupied the dominant position in the tree canopy throughout this study (Figure 3), and will likely maintain this position for several years. The observed decline in sprout numbers (Figure 2) is the result of a self-thinning process. A stump has only limited area and resources to support sprouts. The initially high sprouting response of *P. serotina* and *F. americana* (Figure 6) could not be maintained by the stump, thus these stems exhibited high mortality in the initial stages of the study.

Such rapid declines are common. Lees (1984) reported high initial mortality in *Acer rubrum* (red maple) sprouts, from 75 stems stump^{-1} in the first year following cutting to 30 stems stump^{-1} after 5 years. *P. serotina* has been observed to undergo 50% mortality in the first 2 years following cutting, while *A. rubrum* sprouts underwent a lower, but substantial 30% reduction (Mroz *et al.* 1985). The same study indicated that *A. saccharum* sprouts had better survival during the same period, although its initial sprouting response of 25 stems stump^{-1} was higher than that observed at McCowan Road. The sprouts at McCowan Road are expected to slowly undergo additional reductions to an estimated 3 to 5 stems stump^{-1} within 20 years (Johnson 1975, Lees 1981).

Several factors have been implicated in the sprouting response. Some, such as the growing conditions (light, moisture and temperature) following cutting, the nutrient reserve in the root system, and the general health of the tree prior to cutting cannot be manipulated to reduce the sprouting response (Schier and Zasada 1973, Blake and Raitanen 1981, Johansson 1986). The time of year that the tree is felled, the method of cutting and the height of the stump can be manipulated to minimize the response. Trees cut in the dormant season tend to produce more sprouts than those cut during the growing season (Schier 1973, Arron 1987). Taller stumps also produce more sprouts (Blake and Raitanen 1981, Johansson 1986). The method of clearing may also be important. Lees (1984) reported that *A. rubrum* trees cut with a chainsaw produced fewer sprouts than those mechanically harvested. Rights-of-way clearing machines which tend to shatter or shred the stump would leave a condition considerably different than the clean cut, low stumps left by chainsaws at McCowan Road, thus the sprouting response may be quite different than that documented here.

The life history characteristics of the sprouts and suckers at this site (Figure 5,6,7) may be useful in scheduling the follow up treatments on a newly established right-of-way, but are of limited use for existing rights-of-ways. The diameter of the stump has a large influence in its initial sprouting response (Brown 1987a). Unfortunately, the initial design of the McCowan Road study was limited to stumps greater than 7 cm in diameter (Kirby 1984), a size which is much larger than that expected on a right-of-way undergoing a regular treatment cycle. The majority of the studies reported in the literature also concentrate on larger trees. Sapling-sized trees have a higher probability of sprouting, although the small stump diameters will only support a few stems (Schier 1978, Powell and Tryon 1979, MacDonald and Powell 1983, Johansson 1986). A transect study at McCowan Road confirmed this (Brown 1987a). Stumps in the 0 to 5cm diameter class

had a higher probability of sprouting, but had fewer and shorter stems on each stump. The recent restrictions to herbicide usage adopted by Ontario Hydro, and the likelihood that these restrictions will be extended in the future, indicate an increased reliance on mechanical methods to remove unwanted species from the right-of-way. As these will be primarily sapling sized trees, additional studies are necessary to fully characterize their sprouting response and determine the most appropriate time of cutting, time between cycles and method of cutting.

5.0 CONCLUSIONS

1. There was little change in the total number of woody stems on the site between 1986 and 1988. However, the composition of the tree community is changing from one numerically dominated by *P. tremuloides* suckers to one dominated by *A. saccharum* and *F. americana* seedlings. The canopy layer is still dominated by the faster growing suckers.

2. The rapid reinvasion of incompatible trees following the initial establishment of the right-of-way indicates that the ground layer vegetation does not effectively control this. Additional studies are necessary to investigate the potential of effective cover crops on new rights-of-way.

3. The total number of stems on the surviving stumps have declined by 820 to 1909 stems. The mean number of stems on each surviving stump is converging to a range of 8 to 10 stems stump^{-1} for all species.

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